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FOSSIL MAIZE FROM THE VALLEY OF MEXICO

BY

ELSO S. BARGHOORN[1], MARGARET K. WOLFE[2] AND KATHRYN H. CLISBY[3]

WITHIN the past decade studies on the origin, antiquity and evolution of maize have received new stimulus from archaeological and palynological discoveries in the southwestern United States and Mexico (Deevey, 1944; Mangelsdorf and Smith, 1949). It now appears well established that a maize culture developed and flourished in the presently semi-arid basins of New Mexico during a period ranging from approximately 3600 B.C., or earlier (Libby, 1951), to approximately 1000 A.D. The morphologically primitive structure of this prehistoric corn, in contrast to its surprisingly recent geologic age, is strong presumptive evidence, though not necessarily proof, that maize originated in the New World and was here developed from its wild state by aboriginal migrants into the American subtropics.

Recently, additional paleontological evidence has been obtained from the Valley of Mexico which indicates a far greater antiquity for the existence of maize in the New World than has yet been revealed by archaeologi-

[1] Department of Biology, Harvard University.

[2] Radcliffe College.

[3] Department of Geology and Geography, Oberlin College.

cal discovery. The evidence has been secured from a series of deep cores taken in Mexico City, in connection with extensive studies of the sub-surface. These cores have been described in some detail by Sears (1952), and Sears and Clisby (1952).

In the course of analyzing the pollen contents of the cores, Mrs. Clisby observed several unusually large grass-pollen grains in sediments close to the 70 meter level in the Belles Artes boring. The size of the grains (75μ to 135μ by acetylation method) at first appeared to preclude the reasonable possibility that they were derived from native wild grasses then extant in the Valley of Mexico. However, careful study of these fossil pollen grains, including detailed comparison with material in the Harvard Pollen Collections and in the Botanical Museum, suggested three possibilities for their botanical affinity, viz: Tripsacum, Zea or Euchlaena (teosinte)—all of the tribe Tripsaceae. If the grains actually proved to be those of *Zea Mays*, as seems most probable on the basis of their size alone, they would extend the fossil record of Indian corn far beyond our presently known chronology for the existence and dispersal of this remarkable genus of the grasses.

In order to establish a critical basis for identification of the fossil pollen, an extensive study was made of the size-range exhibited by the pollen of various species of Tripsacum and by varieties of maize and teosinte. To sustain essential uniformity in the data, all preparations of both living and fossil grains were prepared by the same technique (modification of Erdtman, 1943), and permanent slides were prepared with glycerin jelly as a mounting medium. A total of eight species of Tripsacum, three collections of teosinte and fourteen varieties of modern maize were chosen for purposes of comparison (Table I). A total of 34 large grass-pollen grains were ultimately

TABLE I

AXIS LENGTH, PORE DIAMETER AND PORE-AXIS RATIO IN TRIPSACUM, TEOSINTE, MODERN AND FOSSIL MAIZE

Species	Number pollen grains measured	Pore-Axis Ratio																										Averages		
		3.0	3.2	3.4	3.6	3.8	4.0	4.2	4.4	4.6	4.8	5.0	5.2	5.4	5.6	5.8	6.0	6.2	6.4	6.6	6.8	7.0	7.2	7.4	7.6	7.8	8.0	9.0	Length Grain, μ.	Diameter Pore, μ.	Pore-Axis Ratio
Tripsacum																															
T. australe No. 1	54			1	8	15	16	11	1	2																			57.4	14.3	1:4.0
" " No. 2	25		1	2	3	5	7	4	2	1																			57.2	14.3	1:4.0
T. dactyloides	50			4	2	8	16	10	6		4																		50.2	12.2	1:4.1
T. lanceolatum	49		3	4	7	7	13	4	11																				49.9	12.5	1:4.0
T. latifolium	50			5	9	15	8	8	4	1																			41.9	10.6	1:1.4
T. laxum	50			2	16	16	13	3																					57.2	14.7	1:3.9
T. maizar	25	1	1	1	2	2	6	4	7	1																			41.7	10.3	1:4.0
T. pilosum	42	1	2	3	6	13	10	5	2																				57.1	14.7	1:3.9
Teosinte																															
Mexico, "Chalco"	50						1		2	5	5	14	9	6	6	1		1											81.8	15.9	1:5.1
Guatemala No. 1	31									2	3	5	5	5	6	3	2												86.4	16.0	1:5.4
Guatemala No. 2	32										4	4	6		4		3	2											79.3	14.7	1:5.4
Maize																															
United States																															
Thompson Flint	50											1			5	7	15	6	6	3	3	2	2						120.7	19.4	1:6.2
Thayer Flint	50														2	3	8	5	8	8	6	5	1	1		1	2		122.8	18.8	1:6.5
Knobless	30															2	2	2	8	12	2		2						118.8	18.2	1:6.5
Mexico																															
Chapalote	50													6	8	4	6	8	4	8	4	2							94.9	15.4	1:6.2
Jala	50											1	1	1	5	8	10	7	6	4	5	1					1		96.6	15.6	1:6.2
Nal-Tel	47														2	4	10	6	5	2	2	4	4	1	2	2	1	2	87.2	13.2	1:6.6
Tabloncillo	50											1	2	3	6	6	9	8	3	6		2	2	2					98.6	16.0	1:6.2
Tuxpeño	50												2	2	6	6	8	4	16				4				2		99.0	15.8	1:6.3
Vandeño	50												4	8	7	10	5	5	3	4			1		1	1	1		97.1	16.1	1:6.0
Zapalote Chico	50											2	2	6	2	6	18	8	6										94.7	15.9	1:6.0
Costa Rica No. 1045	50														2		18	4	4	6	2	4	8	2					104.6	16.0	1:6.5
Peru																															
No. 300	50													5	6	9	10	10	7	3									95.7	15.8	1:6.1
No. 420	50											2		2	12	4	14	8	4		2	2							99.0	16.4	1:6.1
No. 427, "Cuzco"	50												1		5	7	16	8	8	2	1	2							92.1	15.3	1:6.0
Archaeological																															
Bat Cave, Late	50											1	1	1	5	3	7	7	10	6		2	3	1	2	1			88.7	14.1	1:6.3
Bat Cave, Early	10											2			1	2	1	1	1		1	1							93.1	15.2	1:6.1
Fossil, Mexico City	14											1		2	1	3	1	2			1	1	2						95.6	15.5	1:6.2

secured from the lower levels of the Belles Artes core. These lower-depth grains received the most careful study, although an additional 44 large grass-pollen grains from the upper levels of the Belles Artes and Madero cores were also examined by the same procedures.

In the course of making measurements, it early became evident that a wide range in the size of the pollen grains characterizes each of the three genera, a condition possibly indicative of their unusual genetic variability. In Tripsacum, a wide-ranging and common genus of subtropical and temperate North America, the *average* for the long axes of the pollen grain varied between 41.7μ in *T. maizar* and 57.4μ in *T. australe*, with an extreme range in the genus of 33.6μ to 64.0μ. In teosinte, of the three forms examined, the *average* length varied between 79.3μ and 86.4μ, with extremes of 74.0μ and 102.0μ; whereas in maize the *average* range fluctuated between 87.2μ (Mexico "Nal Tel") and 122.8μ with extremes of 72μ and 141.7μ. It is evident that the smaller pollen of some of the varieties of cultivated maize measured in this study fall well within the range of teosinte and close to that of the largest Tripsacum grains. It is apparent, therefore, that size alone cannot be utilized for the critical identification of presumed fossil maize pollen, and that of its relatives, unless a sufficient number of intact grains are available to be measured and plotted on size-frequency curves to show the statistical probability of one of three possibilities. Owing to the small number of individual intact grains from the Mexican borings, however, this procedure was not possible.

Because of the paucity of structural features and the undistinctive sculpture pattern of the pollen exines of the three genera under consideration, it became necessary to attempt some other means of distinguishing the three pollen-types. Consideration of the problem led to one

other possibility, viz: a comparison of the ratio in size which exists between the pore (including the annulus) of the pollen grain and that of its long axis (Text Fig. 2).

In order to establish these ratios and to determine their constancy, if any, approximately 50 additional grains were measured from each preparation with respect to these dimensions. In the case of the fossil grains all those exhibiting intact pores were measured. The measurements were averaged and the ratios computed from the averaged value for each species. The results showed encouraging consistency, the ratio of pore to long axis being an unexpectedly conservative value, and, more important to the problem at hand, significantly different among the three species in question. The numerical values computed are shown in Table II.

Although the data are limited to approximately 1000 pollen grains, the differences are so consistent, both with respect to individual grains and averages as well, that the pore-long-axis ratio appears to be a valid means of always distinguishing maize pollen from that of Tripsacum, and in some instances from that of teosinte. It may be noted also in connection with this analysis, that teosinte, a postulated hybrid between maize and Tripsacum (Mangelsdorf and Reeves, 1939), shows an intermediate value both in overall size, and perhaps more significantly, in its pore-ratio. The intermediate value is well in harmony with the postulated hybrid origin of teosinte.

Fossil pollen grains resembling maize, teosinte and Tripsacum in size and in their pore-axis ratios occur in the upper levels of both the Madero and Belles Artes

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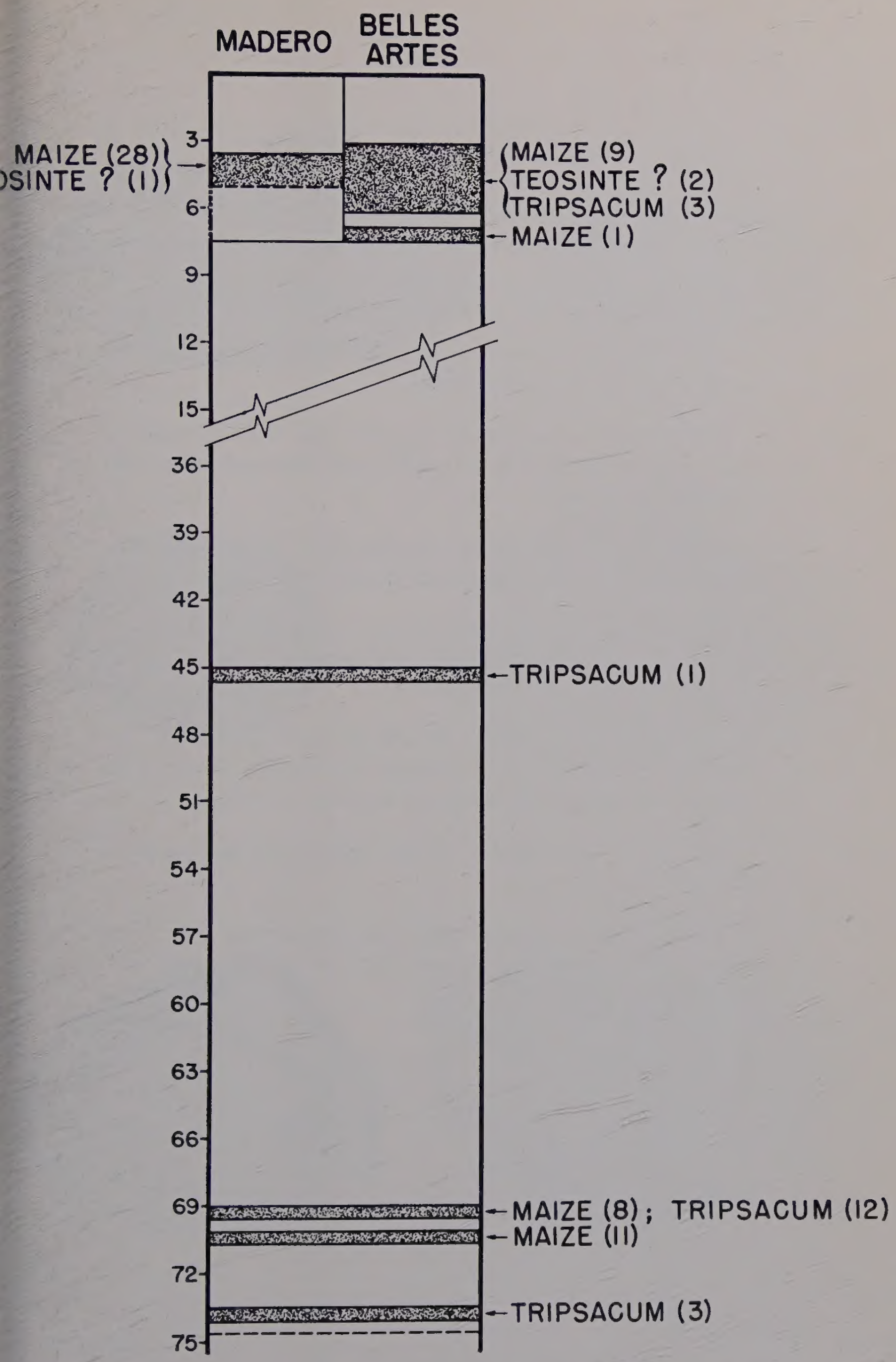
Text Fig. 1 (opposite page). Diagram showing the distribution and frequency of maize, teosinte and Tripsacum in samples studied from the Madero and the Belles Artes cores. Note that the Belles Artes core was sampled throughout, the Madero core only to a depth of 5 meters. Numbers in parentheses indicate the number of individual grains. Depth is indicated in meters.


MADERO
BELLES ARTES
MAIZE (28)
OSINTE ? (1)
MAIZE (9)
TEOSINTE ? (2)
TRIPSACUM (3)
MAIZE (1)
TRIPSACUM (1)
MAIZE (8); TRIPSACUM (12)
MAIZE (11)
TRIPSACUM (3)
3
6
9
12
15
36
39
42
45
48
51
54
57
60
63
66
69
72
75

EXPLANATION OF THE ILLUSTRATION

PLATE XXXVIII. Photomicrographs of fossil, archeological and modern maize pollen grains.

1, Belles Artes core sample number 163, slide number 5. Note pore at extreme upper right, and characteristic folds of the exine. $\times 435$

2, Belles Artes core sample number 148, slide number 1. Pore is clearly visible in upper central portion of grain. $\times 435$

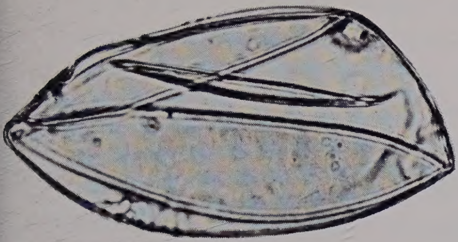
3, Belles Artes core sample number 163, slide number 1a. Pore is visible at lower right. The grain is nearly round, but deeply folded. $\times 435$

4, Bat Cave, New Mexico. Dated by radio-carbon age determination of associated charcoal at 5600$\pm$ years. Note large size of grain and conspicuous pore. $\times 435$

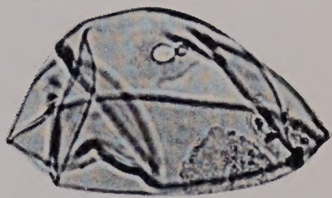
5, Bat Cave, New Mexico. Same source and age as grain shown in fig. 4. $\times 435$

6, Thayer Flint, modern maize, for comparison with fossil maize pollen. Note conspicuous pore in central upper portion of figure. $\times 435$

Plate XXXVIII



1



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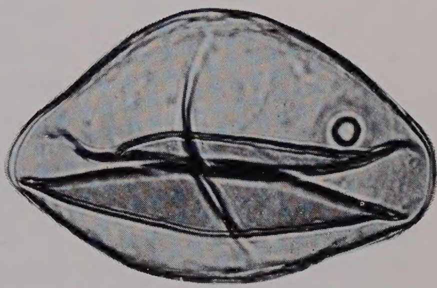

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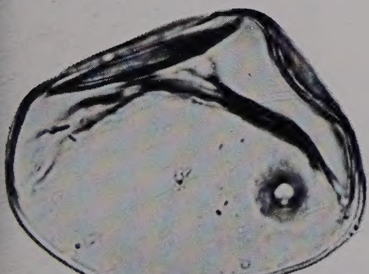

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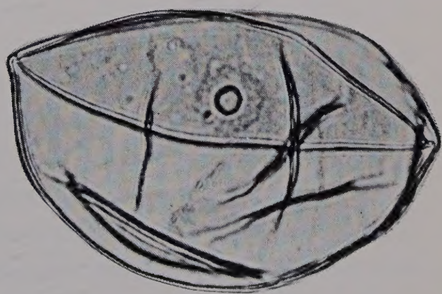

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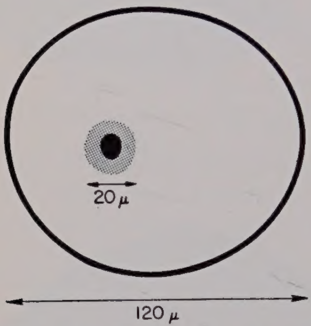
cores. The larger grains, 38 in number, from these upper levels (above 6.0 meters) presumably represent the pollen of cultivated maize, and indeed many grains are well within the upper range of several modern varieties. Three grains of intermediate size and pore-ratio in the upper levels (3.3 and 3.6 meters) possibly represent the pollen of teosinte, a common weed in and around the maize fields in the Valley of Mexico today. Three grains conforming to Tripsacum were secured from the upper levels of the Belles Artes core and, interestingly enough, one Tripsacum grain from the 45 meter level of the same core. No pollen grains clearly assignable to teosinte were found below the 3.6 and 3.3 meter levels respectively in either core (Text Fig. 1). This may indicate that teosinte did not become established in the Valley of Mexico until some time after maize-cultivation had begun. However, the total number of grains involved is small and the differences in levels may represent the product of sampling.



Text Fig. 2. Diagram showing the pore-axis relationship. Note that the outer borders of the annulus (shaded portion surrounding the pore) are included in the pore measurement. (The ratio is determined by dividing the numerical value, in microns, of the long axis by the numerical value, in microns, of the pore.)

By far the most significant discovery is that of large pollen grains, closely resembling modern maize, in the 69 and 70 meter levels in the Belles Artes core. A total of 19 large grains were secured, 14 of which were sufficiently preserved to permit a pore-axis measurement. Of the 19, 8 are well outside the extreme size-range for teosinte, as determined in this study, and of the remaining 11, four are outside the extreme range of the pore-axis

TABLE II

DATA ON INDIVIDUAL FOSSIL POLLEN GRAINS OF TRIPSACEAE FROM MEXICO CITY CORES

Core	Core Sample Number	Slide Number	Depth Meters	Description: Condition	Size μ: Axis	Size μ: Pore	Pore-Axis Ratio	Identification
Belles Artes	148	1	74.2–74.5	elongated	66.0	13.5	4.8	Tripsacum
" "	"	2	" "	good	55.5	12.0	4.6	Tripsacum
" "	"	7	" "	n.p.v.*	45.0	—	—	Tripsacum
" "	163	1	70.3–70.5	entire	90.0	16.5	5.4	Maize
" "	"	1a	" "	good	75.0	13.5	5.5	Maize
" "	"	2	" "	good	93.0	15.0	6.2	Maize
" "	"	3	" "	n.p.v.	132.0	—	—	Maize
" "	"	4	" "	fragment	79.5	13.5	5.8	Maize
" "	"	5	" "	entire	127.0	17.2	7.3	Maize
" "	"	6	" "	fair	124.0	21.0	5.9	Maize
" "	"	7	" "	fair	124.0	18.0	6.9	Maize
" "	"	8	" "	good	87.0	15.0	5.8	Maize
" "	"	9	" "	n.p.v.	129.0	—	—	Maize
" "	"	10	" "	poor	135.0	18.0	7.5	Maize
" "	165	2	69.7–69.9	good	63.0	16.5	3.8	Tripsacum
" "	"	3	" "	pore eroded	63.0	—	—	Tripsacum
" "	"	11a	" "	eroded	64.5	—	—	Tripsacum
" "	"	11b	" "	elongated	69.0	13.5	5.1	Tripsacum
" "	"	16	" "	elongated	60.0	15.0	4.0	Tripsacum
" "	"	19	" "	elongated	67.5	15.0	4.5	Tripsacum
" "	"	23	" "	elongated	64.5	15.0	4.3	Tripsacum
" "	"	26	" "	poor	55.5	15.0	3.7	Tripsacum
" "	"	39	" "	eroded	60.0	12.0	5.0	Tripsacum
" "	"	41	" "	fair	75.5	13.5	5.5	Maize
" "	"	41a	" "	eroded	54.0	—	—	Tripsacum
" "	"	43	" "	fair	79.5	13.5	5.8	Maize
" "	166	2	69.3–69.5	good	92.5	16.5	5.6	Maize
" "	"	3b	" "	good	73.5	12.0	6.1	Maize
" "	"	12	" "	crushed	70.5	10.5	6.7	Maize
" "	"	18a	" "	good	75.0	15.0	5.0	Maize
" "	"	18b	" "	fair	55.5	12.0	4.6	Tripsacum
" "	"	21	" "	fair	84.0	12.0	7.0	Maize
" "	"	26	" "	pore poor, fragment	54.0	—	—	Tripsacum
" "	"	31	" "	good	105.0	16.5	6.3	Maize
" "	"	47	" "	good	109.5	15.0	7.3	Maize
" "	"	63	" "	pore not clear	66.0	15.0	4.4	Tripsacum
" "	189	1	45.1–45.3	pore not clear, grain elongated	72.0	—	—	Tripsacum
" "	232	1	7.4–7.6	very poor, fragment	135.0	—	—	Maize
" "	234	3	5.9–6.1	good	103.5	15.0	6.0	Maize
" "	235	5	5.1–5.2	good	52.5	12.0	4.3	Tripsacum
" "	"	8	" "	good	112.5	19.5	5.7	Maize
" "	"	9	" "	fair	82.5	15.0	5.5	Maize
" "	"	10	" "	fair	97.5	16.5	5.9	Maize
" "	236	4	4.4–4.6	fair	76.5	12.0	6.3	Maize
" "	"	5	" "	pore not clear	79.5	—	—	Maize
" "	"	7	" "	pore not clear	90.0	—	—	Maize ?
" "	"	8	" "	good	45.0	9.0	5.0	Tripsacum
" "	"	10	" "	n.p.v.	82.5	—	-	Maize
" "	237	11	3.6–3.8	pore not clear	55.5	—	—	Tripsacum
" "	"	12	" "	pore not clear	70.5	15.0	4.7	Teosinte ?
" "	"	13	" "	pore not clear	69.0	12.0	5.7	Maize
" "	"	14	" "	pore not clear	64.5	15.0	4.3	Teosinte ?
Madero	135	1	6.0	elongated good	130.0	15.0	8.8	Maize
"	130	1	5.1	n.p.v.	126.0	—	—	Maize
"	128	1	4.9	good	132.0	21.0	6.2	Maize
"	"	2	"	n.p.v.	96.0	—	—	Maize
"	"	4	"	n.p.v.	87.0	—	—	Maize ?
"	"	6	"	n.p.v.	99.0	—	—	Maize
"	"	7	"	elongated	144.0	—	—	Maize
"	126	1	4.5	n.p.v.	103.5	—	—	Maize
"	"	3	"	good	120.0	19.5	6.1	Maize
"	"	4	"	n.p.v.	99.0	—	—	Maize
"	"	6	"	good	105.0	18.0	5.8	Maize
"	124	1	4.1	pore not clear	140.0	—	—	Maize
"	"	2	"	pore not clear	105.0	—	—	Maize
"	"	3	"	n.p.v.	105.0	—	—	Maize
"	"	4	"	pore not clear	99.0	—	—	Maize
"	"	5	"	fair	135.0	16.5	8.1	Maize
"	120	1	3.3	n.p.v.	127.5	—	—	Maize
"	"	2	"	good	99.0	16.5	6.0	Maize
"	"	3	"	n.p.v.	112.5	—	—	Maize
"	"	4	"	pore not clear	66.0	12.0	5.5	Teosinte ?
"	"	5	"	good	124.0	18.0	6.9	Maize
"	"	6	"	n.p.v.	124.5	—	—	Maize
"	"	7	"	n.p.v.	105.0	—	—	Maize
"	"	8	"	good	124.0	18.0	6.9	Maize
"	119	1	3.1	fair	90.0	15.0	6.0	Maize
"	"	2	"	n.p.v.	100.3	—	—	Maize

* n.p.v. indicates no pore visible for measurement.

ratio for teosinte, although within the upper level of the long axis dimension of teosinte. The existence of these large fossil grass-grains at these great depths calls for an explanation and the following possibilities must be considered.

1. The fossil grains are those of a wild grass, not related to maize or its relatives. This possibility seems quite remote, since, except for the cultivated cereals of the Old World, no grass pollen approaching this size is known.

2. The grains represent contamination occurring in the laboratory. This possibility has been eliminated from consideration by re-examination and re-isolation of grains from additional samples of the core sediments. It may also be ruled out on the grounds of the physical, chemical and optical properties of the fossil grains when compared to modern maize pollen.

3. The grains represent contamination which occurred in Mexico during the core drilling (a) either as atmospheric contaminants or (b) as stratigraphic contaminants during the drilling operations. Possibility 3a can be excluded on the same grounds as possibility 2. Possibility 3b can logically be excluded on the ground that if the large fossil grains were carried down from the upper 6 meter levels, they should be found at intermediate depths. However, the large grains have not been found between the 6 meter level and the 69 meter level, with the sole exception of the one Tripsacum grain referred to previously.

4. The grains are those of either Tripsacum or teosinte

which have increased in size and corresponding pore-axis ratio as a result of preservation under rather unusual sedimentary conditions. There is obviously no way to prove that this is not true, but if it were the case, it would be totally inconsistent with previous extensive experience by numerous investigators in dealing with Pleistocene and Tertiary microfossils.

5. The pollen grains are those of ancient maize. This appears to be the most reasonable interpretation and certainly from the evidence now at hand the only plausible one. The large fossil grains resemble maize pollen not only in their general appearance but in their size, and when it can be determined, in their pore-axis ratio. They differ somewhat from pollen grains of modern maize in possessing a slightly thicker exine and, more significantly, a smoother contour in folding. Although these differences may be due in part to conditions of preservation and post depositional change, it is of interest to note that the prehistoric pollen from Bat Cave, New Mexico shares these properties to some extent; but they are less evident in modern maize (Plate XXXVIII).

Only one of the well preserved grains from the lower levels does not fall within the range of Tripsacum or maize. This grain measures 70.5μ in length, with a pore-axis ratio of 4.7, which is outside the range of maize as determined by our measurements. In pore-ratio it is just within the extreme for Tripsacum and the lower range for teosinte. Whether this one specimen represents an unusually large grain of Tripsacum, other grains of which have been found at this level, or a slightly atypical grain of teosinte, cannot be determined. There remains a re-

mote possibility, therefore, that both maize and teosinte were growing at the time the deeper sediments were deposited.

Although definite palynological and geologic conclusions have not yet been drawn as to the antiquity of the lowest portions of the Mexico City cores, the available evidence indicates that the sediments extend well back in Wisconsin time, most probably to the early stages of the Iowan advance of the Wisconsin Ice sheet.[1] If this is the case, the fossil maize pollen with which we are concerned almost certainly antedates the practice of agriculture in North America, and probably precedes the advent of man on this continent.

[1] Personal communication from Professor Paul B. Sears.

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A NEW NARCOTIC SNUFF FROM THE NORTHWEST AMAZON

BY

RICHARD EVANS SCHULTES

I.

AN interesting new drug has been added to our growing list of native narcotic and stimulant plants of South America. Recent investigations have uncovered the use amongst certain Indians of eastern Colombia and northwestern Brazil of several species of the myristicaceous genus *Virola* in the preparation of a violently toxic snuff which is employed by the medicine-men in witchcraft, divination and the diagnosis of illness.

II.

During the course of exploration of the Río Apaporis in Amazonian Colombia in 1951 and 1952, I had as helpers several Indians of the Puinave tribe from the little known Río Inirida. The Inirida is the highest Colombian affluent of the Orinoco and, although botanically completely unknown, it represents apparently an area where the Amazon (Río Negro-Vaupés) and Orinoco floras blend. Consequently, my Puinave helpers, from whom I first learned of this myristicaceous snuff, were familiar with many of the plants encountered in the Apaporis basin.

During 1951, the uninhabited Río Apaporis was opened up for tapping wild rubber, and natives from

various tribes of the Colombian Comisaría del Vaupés and the Rio Uaupés of Brazil were transported into the area by air. Thus, I had an unparalled opportunity of investigating the preparation of the narcotic by natives of tribes isolated from one another by long distances. To the present, the investigation has disclosed the use of the snuff in Colombia amongst the Puinaves of the Río Inirida, the Kuripakos of the Río Guainía, the Kubeos of the Río Vaupés and its Colombian affluents, the Tukanos of the Ríos Vaupés and Papurí, the Barasanas and Makunas of the Rio Piraparaná and the Taiwanos of the Río Kananarí. In Brazil, its use is known amongst the Tukanos of the Rio Uaupés, and there is some indirect evidence that the several tribes of the Rio Issana likewise employ it.

The narcotic snuff prepared from species of *Virola* is called *yá-kee* in Puinave and *yá-to* in Kuripako; the Tukanos call it *pa-ree-ká*, which is a loan word from the Nheêngatú or Lingoa Geral *paricá*, the term by which the snuff is known in the Rio Negro-Uaupés area of Brazil.

The species of *Virola* employed in preparing the narcotic snuff have been verified as the following:[1]

1. **Virola calophylla** *Warburg* Nova Acta Acad. Leop.-Carol. 68 (1897) 231.

Myristica calophylla Spruce Journ. Linn. Soc. 5 (1860) 4, *nomen nudum.*

Virola incolor Warburg *loc. cit.* 232.

Otoba incolor Karsten ex Warburg *loc. cit.* 232, *in synon.*

This species is known from Amazonian Brazil and adjacent parts of Colombia, Peru and Venezuela. Prior to the collection of the material cited below, the species was known in Colombia only from Villavicencio. Subsequent

[1] I acknowledge gratefully the verification of my identifications by Dr. A. C. Smith of the Smithsonian Institution.

collections and observations have shown it to be rather common in Amazonian Colombia. The type (*Spruce 3207*) was collected a century ago by Spruce along the Casiquiare in Venezuela.

The following collections of *Virola calophylla* are those upon which the identification of one source of the narcotic snuff was made.

COLOMBIA: Comisaría del Amazonas, Río Apaporis, Soratama, entre el Río Pacoa y el Río Kananarí. Alt. about 250 m. "Small tree about 35 feet tall; diameter 8–9 inches. Bark exudes inside a reddish resin when ripped off tree. Externally reddish brown, pebbled. Puinave = *yá-kee*. Source of narcotic snuff. In flood-forest." June 26, 1951, *Richard Evans Schultes & Isidoro Cabrera 12855*.—Same locality. "Large columnar tree. Source of *yá-kee* snuff. Flood-forest." August 16, 1951, *Schultes & Cabrera 13587*.

2. **Virola calophylloidea** *Markgraf* Repert. Sp. Nov. 19 (1923) 24.

Virola lepidota A. C. Smith in Brittonia 2 (1936) 152.

This species, the type of which was collected in Manáos by Ule (*Ule 8846*) half a century ago, is rare in Amazonian Brazil in the Rio Negro and Rio Madeira valleys. Hitherto, it has not been known from Colombia, where it appears to be much less common than *Virola calophylla* in the Amazonian regions.

The following collection of *Virola calophylloidea* is that upon which the identification of the second source of the narcotic snuff was made.

COLOMBIA: Comisaría del Amazonas, Río Apaporis, Soratama, entre el Río Pacoa y el Río Kananarí. Altitude about 250 m. "Small tree along flood-bank. Flowers brownish. Puinave name = *yá-kee*. Source of narcotic snuff." July 3, 1951, *Richard Evans Schultes & Isidoro Cabrera 12872*.

3. **Virola** spp.

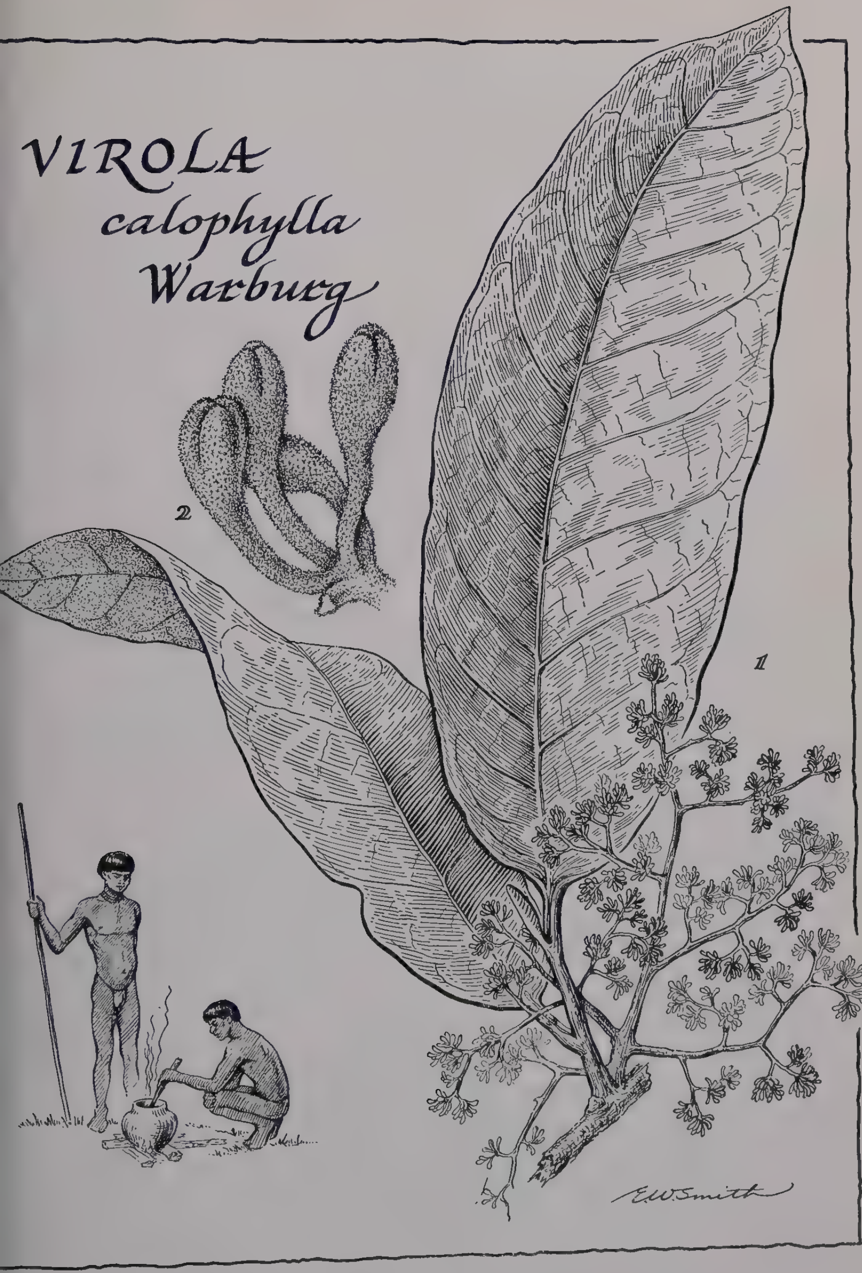
The possibility that other species of *Virola* are used in this way must not be overlooked. The Tawaino Indians of the Río Kananarí in Amazonian Colombia pointed out

EXPLANATION OF THE ILLUSTRATION

PLATE XXXIX. VIROLA CALOPHYLLA *Warburg*. 1, habit, approximately one half natural size. 2, flowers, approximately ten times natural size.

Drawn by ELMER W. SMITH

ATE XXXIX



EXPLANATION OF THE ILLUSTRATION

PLATE XL. VIROLA CALOPHYLLOIDEA *Markgraf.* 1, habit, approximately one half natural size. 2, flowers, approximately ten times natural size.

Drawn by ELMER W. SMITH

PLATE XL

a tree of this genus as representing their source of *paricá*, but there seemed to be some disagreement amongst the several informers. A sterile collection from the tree has been determined with reservation by Dr. A. C. Smith as *Virola elongata* (Benth.) Warburg.

COLOMBIA: Comisaría del Vaupés, Río Kananarí, at base of Cerro Isibukurí, August 4, 1951, *Richard Evans Schultes & Isidoro Cabrera 13278*.

III.

What seems almost certainly to have been this unusual narcotic *Virola*-snuff was apparently first noticed and reported by the famous German ethnologist, Theodor Koch-Grünberg, who explored the northwest Amazon and adjacent areas in the upper Orinoco basin in the early part of this century. The botanical source of the snuff, however, was not ascertained. Writing of the Yekwaná (Yecuaná) tribe of the Río Ventuari in Venezuela, Koch-Grünberg (Koch-Grünberg: "Von Roraima zum Orinoco, Ergebnisse einer Reise in Nord-Brasilien und Venezuela in den Jahren 1911–13" 3 (1923) 386) reported the following concerning this narcotic:

> Of an especial magical importance are the cures during which the witch-doctor inhales *hakúdufʰa*. This is a magical snuff used exclusively by the witch-doctors and prepared from the bark of a certain tree which, pounded up, is boiled in a small earthenware pot until all the water has evaporated and a sediment remains at the bottom of the pot. This sediment is toasted in the pot over a slight fire and is then finely powdered with the blade of a knife. Then the sorcerer blows a little of the powder through a reed (*kuratá*) into the air. Next he snuffs, whilst, with the same reed, he absorbs the powder into each nostril successively. The *hakúdufʰa* obviously has a strongly stimulating effect, for immediately the witch-doctor begins singing and yelling wildly, all the while pitching the upper part of his body backwards and forwards.

Dr. Adolpho Ducke, profound student of the Amazon flora for more than half a century, has attributed the *paricá* of the upper Rio Negro basin to the leaves of a

species of *Virola.* In a footnote to a discussion of *Piptadenia peregrina* L. he wrote (Ducke, A.: "As leguminosas da Amazônia brasileira" (1939) 41):

Martius and other writers attribute to this species the source of the narcotic *paricá* employed by certain Amazonian Indians (the powder of the crushed seeds is inhaled through the nostrils). Notwithstanding, according to information which I obtained from the natives themselves in two localities in the upper Rio Negro, the *paricá*-powder comes from leaves of species of *Virola* of the *Myristicaceae.*

So far as I have been able to ascertain, this is the first and only reference in the literature to the use of *Virola* in the preparation of a narcotic snuff. I have been unable to substantiate the statement that the leaves are ever used; all of the many reports which I have gathered are in agreement and indicate that the bark is the portion of the plant employed in the preparation of the snuff. Ducke fails to make mention of the identification of *paricá* as *Virola* in the second edition of his "As leguminosas da Amazônia brasileira" (Bol. Técn. Inst. Agron. Norte 18 (1949)).

IV.

It would seem that *Virola* has not hitherto been reported as possessing strong narcotic properties. Nevertheless, extremely toxic and narcotic principles have been found in other members of the *Myristicaceae.* Perhaps the best known case is *Myristica fragrans* Houtt., which "unites to the medicinal properties of the ordinary aromatics considerable narcotic properties"; fatal and near-fatal consequences have attended its careless use in India (Wood, H. C., J. P. Remington and S. P. Sadtler: "The Dispensatory of the United States of America" ed. 18 (1899) 889). This thoroughly studied plant is the source of two spices of commerce: nutmeg and mace—the former derived from the dried, ripe seed without its seed coat and arillode, the latter from the dried arillode. Both

spices are employed medicinally as stimulants and carminatives, but in excessive doses they can produce mydriasis and stupor (Youngken, H. W.: "Textbook of pharmacognosy" ed. 5 (1943) 305 ff), and mace has been known to cause "alarming sensorial disturbances" (Watson, G. C. in Prov. Med. Surg. Journ. (Jan. 26, 1848)). The toxic effects of *Myristica fragrans* are due apparently to a volatile oil, myristicine, which can act as a narcotic and which can cause a fatty degeneration of the liver (Finnemore, H.: "The essential oils" (1926) 274; Guenther, E.: "The essential oils" 5 (1952) 78). According to Youngken (*loc. cit.*), nutmeg contains up to 40% of a fixed oil and up to 10% of a volatile oil (4% of which is the narcotic principle myristicine). The whole family *Myristicaceae* is characterized by the presence of cells which contain a semi-fluid or crystalline oil, the color of which varies from yellow to red or even to a brownish black (Kraemer, H.: "Scientific and applied pharmacognosy" (1915) 250). It would appear probable, then, that the violent narcotic properties of *yákee*-snuff may be due, in great part if not entirely, to myristicine. Pharmacological studies which are at present under way will, it is hoped, clarify this interesting problem.

In the Indian Archipelago and New Guinea, other species of *Myristica* yield nutmeg, but there seems to be no record of the purposeful use of this genus amongst native Asiatic peoples as the source of a narcotic.

V.

The preparation of *yákee*-snuff[2] is relatively simple. I have observed the process several times with Puinave Indians and have also seen the powder prepared by Tu-

[2] Because of the confusion which has grown up around the widely used term *paricá*, which will be discussed fully below, I prefer to employ the short, easily-pronounced and specific Puinave Indian name for the *Virola*-snuff.

kano and Kuripako Indians. In all cases, the fabrication was essentially the same and corresponds closely to Koch-Grünberg's brief description of its manufacture amongst the Yekwanás. Descriptions of the preparation as given to me by several Kubeo, Barasana and Makuna Indians indicate that no appreciable difference marks the process as practised by these tribes. In all instances, the same species were pointed out as sources of the snuff. We are, therefore, justified, I believe, in assuming that, in the area of its distribution in the Comisaría del Vaupés of eastern Colombia, as well as in the upper Rio Negro of Brazil, the preparation of *yákee* is well standardized. In this respect, it resembles coca (*Erythroxylum Coca* Lam.), the fabrication of which is, for practical purposes, the same throughout the area; on the other hand, it is unlike the famed narcotic *caapi* or *yajé* (*Banisteriopsis* spp.), the preparation of which seems to vary with almost each tribe.

The Indians usually strip the bark from the trees during the early hours of the morning, before the sun has begun to penetrate the forest canopy to heat up the trunk. Large strips of the bark, which peel easily from the cambium, are torn from the trunk and tied into loose bundles. Almost immediately upon separation of the bark from the tree, a profuse exudation or "bleeding" of a thick reddish resin-like liquid, which soon becomes viscous, oozes forth from the inner surface of the bark in small drops. The active principle is contained in this exudation—called *oom* (latex), or, specifically referring to these species of *Virola*, *há-oom-tee-ĕt* or *yá-kee-oom*, in Puinave. According to the Indians, this exudation is greatly reduced in quantity and is weaker in its narcotic effects when the trunk of the *Virola* tree has received the warmth of the sun's rays.

The bundles of bark are brought in and placed in water

for about half an hour. They are then taken out, and the soft inner layer, on the surface of which the red exudation has congealed, is rasped off with a knife or machete. The shavings or raspings (*yá-kee-taa* in Puinave) are thrown into an earthen pot or enamel tray, and the rest of the bark is discarded. When enough shavings have been accumulated, a small amount of water is added, and the mass is thoroughly kneaded and squeezed. The water becomes muddy and assumes a brownish or tan hue. This turbid liquid is strained several times, usually through a piece of finely hammered bark-cloth (prepared from a species of *Olmedia*) into a small-mouthed earthenware pot. The residual shavings, when as much of the water has been expressed as possible, are thrown away. Enough water is added to the strained liquid to fill the pot, which is then set to simmer over a slow fire. From time to time, a sordid foam, which rises to the surface, must be scraped off with a piece of bark. The boiling is allowed to continue for three or four hours, more water being added if evaporation be too rapid, until nothing remains except a thick, dark brown syrup at the bottom of the pot. This syrup must not be dried rapidly over a fire; the pot is set in the sun, and the syrup is permitted to solidify slowly. When nothing but a dry, brown crust is left, the residue is scraped free from the pot and is ground into a fine powder with a water-smoothed stone as a pestle and the pot or an enamelware tray as a mortar. It is then ready to be mixed with ashes which have been made, the while, from the bark of a small wild cacao tree (*Theobroma subincanum* Mart.). Usually equal amounts by volume of ashes and *yákee*-powder are used. When they are thoroughly mixed, the product is put into a small bag made of finely hammered bark (*Olmedia* sp.) or cloth and is sifted through the bag by means of a gentle beating against the side of a small-mouthed

receptacle. The resulting dust is the final snuff. It is kept either in a small glass bottle, tightly corked, or else, more traditionally, in a type of jar made, as Koch-Grünberg described, from a large snail-shell to which a hollow bird-bone tube has been fixed with pitch. This tube is stopped with a plug of feathers glued together with pitch at the basal end to form a tight-fitting stopper.

The consumption of *yakee*-snuff is limited to medicine-men and is, therefore, small. Since it is said to lose its intoxicating properties rather rapidly, even when in a tight container, it is made in small amounts and frequently.

VI.

It may be of interest to append a few observations which I was able to make personally after taking *yakee*-snuff. I took about one-third of a level teaspoonful of the drug in two inhalations using the characteristic V-shaped bird-bone apparatus by means of which the natives blow the powder into the nostrils. This represents about one-quarter the dose usually absorbed by a diagnosing medicine-man, who takes about one slightly heaped teaspoonful in two or three inhalations at close intervals (of approximately fifteen or twenty minutes).

The dose was snuffed at five o'clock one afternoon. Within fifteen minutes a drawing sensation over the eyes was felt, followed very shortly by a strong tingling in the fingers and toes. The drawing sensation in the forehead rapidly gave way to a strong and constant headache. Within one half hour, there was a numbness of the feet and hands and an almost complete disappearance of sensitivity of the finger-tips; walking was possible with difficulty, as in a case of beri-beri. Nausea was felt until about eight o'clock, accompanied by a general feeling of lassitude and uneasiness. Shortly after eight, I lay down in my hammock, overcome with a heavy drowsiness

which, however, seemed to be accompanied by a muscular excitation, except in the extremities of the hands and feet. At about nine-thirty, probably, I fell into a fitful sleep which continued, with frequent awakenings, until morning. The strong headache over the eyes lasted until noon. A profuse and uncomfortable sweating, especially of the armpits, and what might have been a slight fever lasted from about six o'clock all through the night. There was a strong dilation of the pupils during the first few hours of the experiment. No food was taken and no tobacco was smoked from the time the experiment began until one o'clock in the afternoon—that is, for twenty hours during the course of the experiment.

Since this experiment was performed under primitive conditions in the jungle, all observations had to be made by myself. In spite of its many and serious shortcomings, the experiment indicates the narcotic strength of the snuff.

The dose employed by the medicine-men is sufficient to put them into a deep but disturbed sleep, during which delirious mumblings or, sometimes, shouts are emitted; visual hallucinations or dreams are reported to accompany the narcotic sleep very often. These are "interpreted" by an assistant who awaits the prophetic or divinatory sounds. Some medicine-men, it is said, are affected more violently than others and uncontrollable twitching of the fingers and facial muscles and a popping of the eyes are not infrequent symptoms. There is one report of the death, about twenty years ago, of a Puinave medicine-man on the Inirida River, whilst he was under the influence of *yákee*. Some *payés* (witch-doctors) are said to take *yákee* as frequently as four or five times a month; usually, so far as I have been able to ascertain, one doctor will not undergo the diagnosis-narcosis with *Virola*-snuff more than once a month. All reports would seem to indicate that it is a dangerous narcotic.

VII.

The use of a snuff commonly called *paricá* has been known for a century or more, and the source of the narcotic has quite generally been attributed to the leguminous tree *Piptadenia peregrina.* This tree has long been recognized as the source of a violently narcotic snuff which is employed by the natives of the Caribbean area and of northern South America, including the basin of the Río Orinoco, and which is widely called *yopo* or *niopo.* Humboldt's account of this snuff (Humboldt: "Voyages aux régions équinoxiales du nouveau continent. . ." 2 (1819) 260) referred to the preparation and utilization of the drug which he had observed in 1802 amongst the Otomaco and Guahibo Indians of the Orinoco in Venezuela and Colombia: "Ex seminibus tritis calci vivae admixtis fit tabacum nobile quo Indi Otomacos et Guajibos utuntur." The plant used was identified as *Acacia Niopo,* now considered a synonym of *Piptadenia peregrina.*

Sir Robert Schomburgk, who first explored British Guiana from 1835 to 1839, referred the narcotic *paricá* or *paricaraná* to *Mimosa acacioides* Benth. (Schomburgk: "Travels in British Guiana" [transl. W. E. Roth] 1 (1922) 92). This binomial is a synonym of *Piptadenia peregrina.*

In June 1854, during his botanical explorations in the vicinity of the cataracts of the Río Orinoco at Maipures, Richard Spruce came upon a wandering group of Guahibo Indians from the Río Meta in Colombia preparing *yopo*-snuff. He described the preparation of the narcotic and attributed it (as *P. Niopo*) to *Piptadenia peregrina* (Spruce, R. [ed. A. R. Wallace] "Notes of a botanist on the Amazon and Andes" 2 (1908) 427), and he reported the common name as *niopo* in Venezuela and *paricá* in Brazil.

Bates, who worked in the Amazon at the same time

as Spruce, reported, but without the support of botanical material, that *paricá* was prepared from a species of *Inga* (Bates, H. W.: "A naturalist on the River Amazon" 1 (1863) 331).

Carl F. P. von Martius (Zur Ethnographie Amerika's sumal Brasiliens" (1867) 390) stated that the Mundurukú Indians of Brazil used *paricá*, a snuff from the "seeds of *Mimosa acacioides*", having borrowed the habit from their neighbors, the Múras and Mauhés. He also (*loc. cit.* 441, 631) asserted that the Omaguas of Peru use this same snuff, and that it was well known amongst the Paravilhanas of the region north of the Rio Negro in Brazil and in British Guiana.

The German ethnologist Koch-Grünberg, who carried out very extensive investigations in the upper Rio Negro and lower Apaporis basins from 1903 to 1905, similarly attributed the *paricá* of this area to *Mimosa acacioides* (Koch-Grünberg, T.: "Zwei Jahre unter den Indianern" 1 (1909) 323). There seems to be no evidence that material for botanical determination supports his identification, which may have been advanced by Koch-Grünberg because of the extreme similarity of the snuff to the already widely known *yopo*-snuff. Koch-Grünberg reported:

> It is a grey snuff with strong narcotic properties, known in Lingoa Geral as *paricá* and prepared from the dried seeds of a species of *Mimosa*. It is kept in small rounded calabashes or in snail-shells, the opening of which usually is closed with a piece of mirror imbedded in pitch and which, as in the case of the calabash, has a bird-bone spout fixed with pitch. . . Snuffing is done through a forked instrument made of two communicating bird-bones, which are glued together with pitch. . . In using it, a bit of the powder is poured from the snuff-box into the palm of the hand and is scooped up into the bird-bone. Then the end of one of the bones is inserted into the nostril, and the other is put into the mouth. With short blows, the fine powder is injected to the furthest membranes of the nose.

In a footnote, Koch-Grünberg (*loc. cit.*) gives a speci-

fic identification, and he makes an observation which might indicate that he had assumed that this identification must be the correct one, even though he had no botanical specimens:

> *Mimosa acacioides* Benth. This snuff is distributed over a great part of tropical South America, from the Orinoco and the Guianas to the southern affluents of the Amazon River. Likewise, the instruments which are used in taking the snuff are very similar.

Somewhat later, Whiffen (Whiffen, T.: "The Northwest Amazonas" (1915) 143) reported that:

> The Tuyuka and other tribes north of the Japurá use as a stimulant *paricá* or *niopo*, a wonderful snuff which is a strong narcotic and very similar in its effects to coca. It is made from the dried seeds of a mimosa, and like coca, is mixed with quicklime and baked clay. The seeds are roasted and then pounded in a shallow wooden mortar, and the snuff, when made, is packed in snail-shells and is inhaled through hollow bird-bones inserted in both nostrils.

It would appear that this reference of Whiffen (who never visited the Tuyuka country) to the snuff used by the tribes north of the Caquetá (Japurá) may be based upon Koch-Grünberg, for in speaking of the Andoke and Karihona tribes, he wrote (*loc. cit.*):

> They all use tobacco-juice, coca, and a white snuff that I thought must be the famous *niopo* but could not find out anything about it.

My own assumption would be that this "white snuff" is actually nothing but tobacco-snuff, which is widely used in the upper Amazon area, where it is always a greyish preparation, because of the large amount of ash mixed with the pulverized tobacco. It cannot be the myristicaceous snuff, for even after the admixture of ashes, this is of a brownish color. Furthermore, the use of the *Virola*-snuff is restricted to a few practitioners and is not permitted to all members of the tribe.

Recently, Mr. Paul H. Allen, who was engaged during 1944 in botanical work in the region of the Vaupés River and its affluents, reported (Allen, P. H.: "Indians

of southeastern Colombia'' in Geogr. Rev. 37 (1947) 579) that the Kubeo Indians of the Kuduyarí River employ *paricá*. He gives as the source of *paricá* the leguminous *Piptadenia peregrina:*

The powdered seeds of *paricá* (*Piptadenia peregrina*) are blown forcefully through a bone into the nostrils of the *payé*, producing a sort of ecstasy, during which he determines the guilty party [i.e. enemies who have sent sickness through the air].

In a letter (January 14, 1952), answering my query as to his designation of the source of the snuff, Allen writes me that he did not see the seeds of *Piptadenia* himself; that he had been informed that seeds were used in the area; and that, on the basis of the literature, he concluded that these represented *Piptadenia peregrina.*

It would seem, therefore, that there is much confusion of *paricá* with *yopo.* This stems primarily from Spruce's account, for he recorded (*loc. cit.* 427):

I first gathered specimens of the *paricá* (or *niopo*) tree in 1850, near Santarém, at the junction of the Tapajóz and Amazon, where it had apparently been planted. In the following year, I gathered it on the little river Jauouarí—one of the lower tributaries of the Rio Negro—where it was certainly wild. But I did not see the snuff actually prepared from the seeds and in use until June, 1854, at the cataracts of the Orinoco.

We know that Spruce was aware of Humboldt's report of *yopo*-snuff. Upon finding the same tree in an area such as the Rio Negro where, according to local reports, the medicine-men took a snuff called *paricá*, it is possible that Spruce assumed that *Piptadenia peregrina* was also the source of the *paricá*-snuff. This is not an easy explanation to accept, for Spruce deservedly enjoys the reputation of one of the most critical and accurate of ethnobotanical students of South America. Nor are we at all certain to this date that *paricá* does *not* refer to snuff made with *Piptadenia* seeds in *some* parts of the Amazon Valley. Furthermore, we have the reports of

EXPLANATION OF THE ILLUSTRATION

PLATE XLI. Stripping bark from VIROLA CALOPHYLLA for the preparation of *yakee*-snuff. Río Apaporis, Comisaría del Amazonas, Colombia.

Photograph by RICHARD EVANS SCHULTES

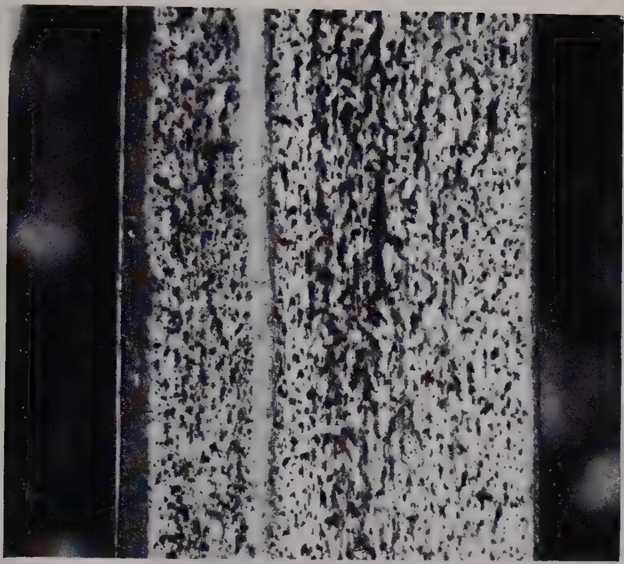
EXPLANATION OF THE ILLUSTRATION

PLATE XLII. (*Top*) A photograph of the inner surface of the bark of VIROLA CALOPHYLLA (*Schultes & Cabrera 12855*), showing the red resin-like exudation which is elaborated into *yakee*-snuff. Río Apaporis, Comisaría del Amazonas, Colombia.

(*Bottom*) The thick syrup resulting from the boiling of the scrapings of the inner bark of VIROLA CALOPHYLLA is allowed to dry before being pulverized and mixed with ashes of THEOBROMA SUBINCANUM in the preparation of *yakee*-snuff. Río Apaporis, Comisaría del Amazonas, Colombia.

Photographs by RICHARD EVANS SCHULTES

Plate XLII



Koch-Grünberg stating that the narcotic snuff of the northwest Amazon is derived from a legume. Nevertheless, we must emphasize Spruce's own words that he "*did not see the snuff actually prepared from the seeds and in use. . .*" in the Rio Negro area.

Some of the records of a narcotic snuff from the Amazon Valley might actually refer to *Piptadenia*, as, for example, Herndon's report (Herndon, W. L.: "Exploration of the Valley of the Amazon" (1854) 319), which he attributed to a trader of snuff amongst the Mundurukú Indians of the Rio Tapajóz. This snuff is reported to be made from powdered seeds, not from bark, which would suggest *Piptadenia* and not *Virola*. But, the Mundurukú *paricá* is composed of several constituents:

Several vegetable substances compose *paricá:* first, the ashes of a vine that I cannot class, not having been able to procure the flowers; second, seeds of the *Acacia angico* of the leguminous family; third, juice of the leaves of the *abuta* (cocculus) of the menispermes family.

In the twelve years which I have devoted to the study of the flora of the northwest Amazon, I have never seen *Piptadenia peregrina* either cultivated or wild in the area. I have never seen any snuff prepared from leguminous seeds in this area, nor have I heard of the practice which appears, in Colombia, to be confined to the Orinoco basin. The Puinaves, who live on the Inirida and Guaviare, where Amazon and Orinoco tribes meet, are acquainted with *both* the myristicaceous and the leguminous snuff and are quick to distinguish between the two.

Whether or not *paricá*-snuff is prepared from a leguminous plant in some parts of the Amazon, it is quite definite that the term *paricá* in most parts of the lower Amazon does refer to certain trees of the *Leguminosae*. *Paricá* is employed in Brazil to denote *Cassia fastuosa* Willd., *Cedrelinga catenaeformis* Ducke, *Parkia* spp., *Piptadenia* spp., *Pithecolobium* spp., *Schizolobium ama-*

zonicum (Hub.) Ducke, *S. parahybum* (Vell.) Blake, and *Senegalia* spp. Numerous derivative terms, such as *paricá branca, paricá de cortume, paricá da terra firme, paricá grande da terra firme, paricá da varzea, paricaraná* and *paricazinho* are likewise applied to species of the *Leguminosae* (Record, S. J. & R. W. Hess: "Timbers of the New World" (1943) 242 ff.; Le Cointe, P.: "Arvores e plantas úteis," ed. 2 (1947) 387 ff.; Ducke, A.: "As leguminosas da Amazônia brasileira" (1939) 164–165; Penna, M.: "Diccionario brasileiro de plantas medicinais" ed. 3 (1946) 295; Huber, J. in Bol. Mus. Para. Hist. Nat. Ethnog. 6 (1909) 213).

The only pronouncements which we can, at this moment, make are (1) that *the paricá of the Rio Negro-Uaupés basin is prepared from the bark of certain species of the myristicaceous genus Virola and not from the seeds of the leguminous genus Piptadenia;* and (2) that *Piptadenia-snuff or yopo is* (*at least, at the present time*) *probably unknown and most certainly not employed in this area.*

As the foregoing discussion has pointed out, the identification of the botanical sources of South American narcotic snuffs in general and of those called *paricá* in particular is in a state of extreme confusion. To a great extent, this is directly attributable to the habit, in anthropological and geographical articles, of using the common names and of depending upon common names and not botanical material for plant identification. This has been most forcefully emphasized in a recent and excellent summary of our knowledge of stimulants and narcotics of the South American Indians, in reference to the various snuffs attributed to *Piptadenia* (Cooper, J. M.: Bur. Amer. Ethnol. Bull. 143 (1949) 536, map 10):

> Our tribal records on which the above list and accompanying distribution map (map 10) are based are probably very incomplete. On the other hand, some of the attributions may not be correct, since in some cases the lack of exact botanical identification makes it doubtful

whether we have to do with *Piptadenia* snuff, tobacco snuff, or snuff from some other plant—as, for instance, the 'topsayri' in early Peru—or from an unidentified tree bark among the Yecuaná. . .

There is, in this problem of the identity of *paricá*, a most curious phase which is, as yet, apparently far from solution.

In the kits which contain the witch-doctor's paraphernalia amongst certain tribes on the Río Vaupés and the upper Río Piraparaná, there is always a lump or two of a clear yellow amber-like resin. This is used as a snuff, but seems to have no narcotic properties. Before a "diagnosis", the medicine-man rasps a small amount of this resin and pulverizes it finely, after which it is taken into the nostrils. The resin, when powdered, is slightly aromatic. It is my belief that the use of this resin as a snuff is related perhaps to a kind of "purification", preparatory to making a diagnosis, but we have very little information about it. I suspect that the source of the resin might be a species of *Clusia*, but I have no personal observations to offer in support of this suspicion. There is the barest of possibilities that the resin might be of myristicaceous origin, for we recall that *Myristica Bicuhyba* Schott of Brazil yields a balsam which is sometimes substituted for copaiba (*Copaifera officinalis* L.), (Kraemer, H.: " Scientific and applied pharmacognosy" (1915) 250). There is no actual evidence, however, for such a belief.

I have seen these lumps of *paricá* amongst the Barasana Indians of the Caño Tee-mee-ña, an affluent of the Río Piraparaná. It was impossible to procure material or a description of either its preparation or of the source tree—but we know that it is procured from a large tree of the forest.

Two of my colleagues, who spent long periods in the Colombian Vaupés, have likewise encountered this ele-

ment of the local doctor's kit. Mr. Paul H. Allen (in litt., January 14, 1952) has written the following information to me:

> *Payé* [witch-doctor] kits seen in the Bajo Vaupés, but particularly from the lower Querarí and vicinity, contained lumps of an amber gum, which local people told me was the active principle of *paricá*. I doubted it very strongly, and the *payés* were far too suspicious and resentful of my collecting activities to be very communicative, much less to be willing to stage a demonstration.

Dr. Lothar Petersen, a physician in Bogotá who spent many months in medical studies amongst the Indians of the Vaupés, likewise found these lumps of resin and reports that it is known locally as *paricá.* He procured several lumps from a witch-doctor in the headwaters of the Río Piraparaná, but he also was unable to learn the tree from which the resin was obtained. Dr. Petersen has kindly given me two small lumps which will be studied chemically in an attempt to ascertain their approximate composition and, thus indirectly, perhaps to discover their botanical source.

It is clear from the problems raised in the present paper that much botanical work still must be carried on in our study of narcotic and stimulant plants in the Amazon Valley. It is hardly believable that such a widely used and virulent narcotic snuff as *yákee* would have to wait until this late date in the history of botanical exploration of the Amazon for identification. It makes one wonder how many more narcotic plants, up to now obscured by better-known ones, still wait to be discovered.

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THE ORIGIN AND POSSIBLE EVOLUTION OF SUB-TASSEL EARS IN MAIZE

BY

Walton C. Galinat [1]

Modern maize has many vestiges which may reflect primitive characteristics of wild maize and its relatives. One of the least mentioned and possibly most significant rudiments in modern maize is the remains of a spathe subtending the lowermost tassel branch or pair of tassel branches. Anderson (1951) has described this vestige as "a kind of little ridge or scar as if a leaf had started to grow out and then had been pulled off." Sometimes this spathe is well-developed and associated with a small sub-tassel ear, as is evident in at least two published illustrations (Häckel, 1887; Weatherwax, 1916—fig. 10). Such an ear near the base of the tassel may be derived from a single staminate spikelet (Weatherwax, 1925).

An examination of over 1000 tassels from varieties of maize from North, Central and South America in the Maize Herbarium of Dr. Paul C. Mangelsdorf revealed a series of types ranging from a reduced and sometimes adnate spathe subtending the lowermost tassel branch to a fully developed leaf borne at a node with a small sub-tassel ear. The adnate or vestigial spathe and its derivations were found in over 70 per cent of the population studied. Sub-tassel spathe development was especially

[1] Research Fellow at the Bussey Institution of Harvard University.

frequent and pronounced in varieties from Bolivia and Peru. This feature is enhanced by tassel proliferation resulting from unfavorable photoperiods during floral differentiation of short-day maize and is also characteristic of tunicate, corn-grass and teopod maize. Tassels which were proliferated or associated with any of the above variants were excluded from this study.

Specimens of *Tripsacum* and *Euchlaena* from the Economic Herbarium of Oakes Ames were examined in an attempt to determine if this rudimentary spathe might be derived from introgression with these near relatives of maize. It was found that in *Tripsacum pilosum*, *T. lanceolatum*, *T. dactyloides* and *T. fasciculatum* there is a small ridge encircling the base of the inflorescence. In these species, with *T. dactyloides* as a possible exception, the ridge is more in the nature of a fracture line for the lowermost rachis-fruit case than that of a vestigial leaf. In *Euchlaena mexicana* there is often a small leaf-like protrusion subtending the lowermost tassel branch. This structure is probably a vestigial spathe since its homologue subtending a lateral pistillate spike is a well-developed spathe. The degree of development of the spathe subtending the tassel of *Euchlaena* appears to be, on the average, intermediate between that of *Tripsacum* and that of maize.

In modern maize, partial development of the subtassel spathe and its axillary branch is usually associated with various anomalies. Both the spathe and its axillary peduncle may be adnate to the rachis. The peduncle may adhere to the rachis over a greater distance than its subtending spathe (Figs. 1–3). The auricles of the spathe may be greatly elongated on either side of a reduced blade (Figs. 4–6). Development of the spathe may be unilateral in relation to the branch, so that it appears as if its blade had been cleaved down the midrib and torn

off on one side (Figs. 7–9). Various twisted configurations may distort the spathe, rachis, and peduncle as the branch tends to become opposite rather than adjacent to its associated spathe (Figs. 10–13). If the axillary branch develops to one side of, or on the opposite side of, the node at which a terminal leaf would normally be expected, then both spathe-leaf and branch may achieve optimum development (Fig. 14). Two leaves, or a leaf and a sheath (husk), may be borne at this node. Such a pair of leaves (Figs. 15, 17) may have a common origin (Figs. 7–9), although distortion of the node may cause them to appear as being separated by a short and twisted internode (Fig. 13). In extreme cases of spathe development, a single spikelet or the tassel branch as a whole may be modified to form a small shank terminated by a small ear (Figs. 15–17). The morphological change from either a spikelet or tassel branch to a many-ranked ear involves a change from bilateral to radial symmetry. Such a transformation is common in maize. Depauperate ears frequently exhibit reductions from a radial to a bilateral condition. One might expect that, if there were a reduction during evolution of a leaf terminal to the culm, then there might also be a corresponding reduction of its axillary ear to a bilateral tassel branch.

Archaeological remains have been found which suggest that sub-tassel ear development may have been characteristic of primitive maize (Mangelsdorf, 1954 and unpub.). This evidence, so far as it goes, indicates that the tassel of wild maize was unbranched or sparsely branched and bore a few pistillate spikelets basally. The spathe subtending the tassel may have had a protective function for these pistillate spikelets during the prepollination period. Subsequent to pollination, rapid elongation above the sub-tassel node might elevate the mature grain for dispersal. Mangelsdorf has suggested (unpub.)

EXPLANATION OF THE ILLUSTRATION

Plate XLIII. 1, 2, 3, profile, front and rear views respectively, of the divergence point of the lowermost peduncle from the rachis and its subtending spathe-rudiments which are adnate to the rachis. Natural size.

4, 5, 6, as in previous figures, with the addition of abnormally elongated auricles to an otherwise inhibited spathe. Natural size.

7, 8, 9, as in previous figures, showing cleavage of the spathe followed by unilateral development. Natural size.

10, 11, 12, as in previous figures, except for the equal development of the rudimentary parts of the spathe. Natural size.

13, unilateral spathe development at a twisted and elongated node. One half natural size.

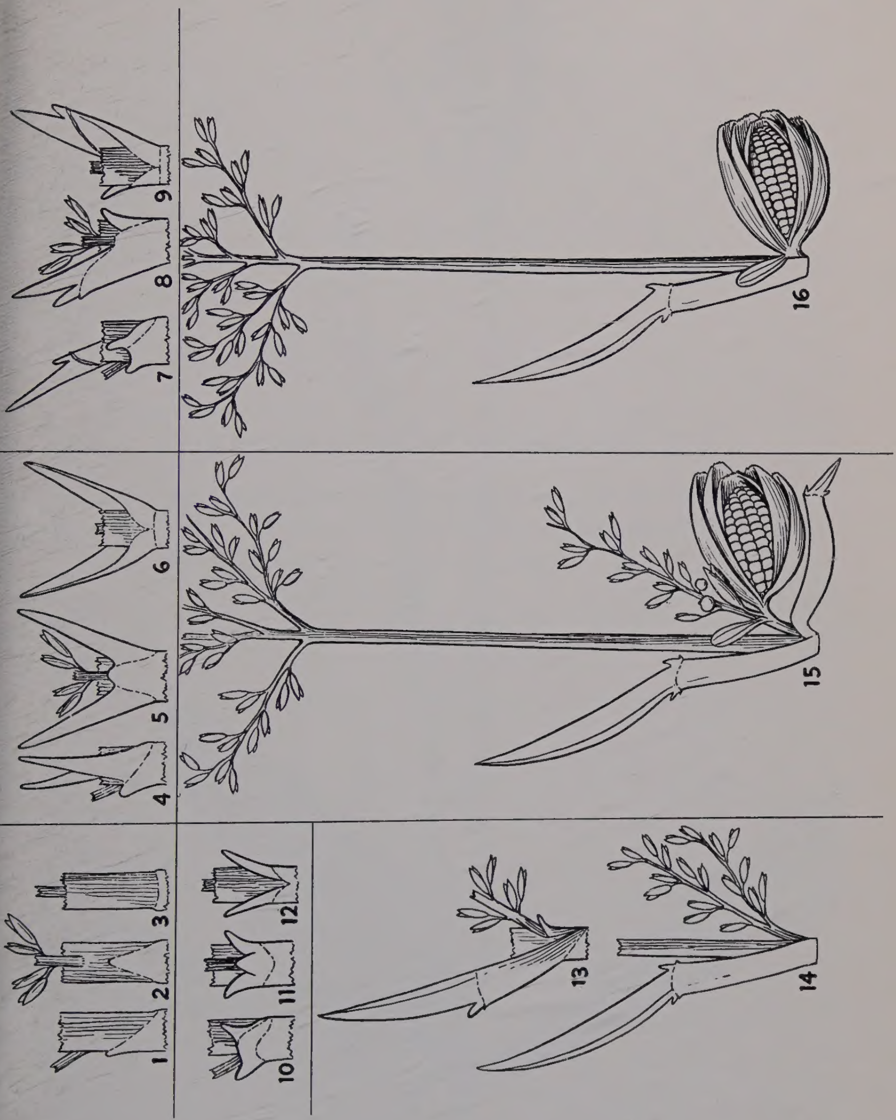
14, tassel branch development on the opposite side of the node from its associated spathe. One half natural size.

15, sub-tassel ear development from a modified sessile staminate spikelet. Two leaves, probably of common origin, are borne at this node. One half natural size.

16, sub-tassel ear borne opposite a leaf at the same node. One half natural size.

Drawn by Walton C. Galinat

PLATE XLIII



EXPLANATION OF THE ILLUSTRATION

Plate XLIV. 17, photograph of a sub-tassel ear of similar nature to that shown in Fig. 15.

Photograph by Paul C. Mangelsdorf

Plate XLIV

that such a little sub-tassel ear, borne opposite this spathe, may have attracted man to domesticate an otherwise earless form of primitive wild maize. The present variability in development of this sub-tassel ear or its rudiments might be attributed to its presence in only one or a few of several geographical races of wild maize. It may have also been variable in its expression in wild maize, perhaps dependent on growing conditions.

The frequent adnation of the sub-tassel spathe and its axillary peduncle to the rachis may be another indication of the important role that adnation has played in the development of the inflorescence and plant of maize. The cupule, a structure in maize associated with the attachment point of a pair of pistillate spikelets to the rachis, has probably been formed by a prophyll adnate to the rachis (Nickerson, 1954).

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